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Assessment of nutritional and chemical characteristics of tiger nut juice consumed by inhabitants of two communities in Cross River State, Nigeria

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ABSTRACT

Background: Monitoring and evaluation of food and their products are critical to maintaining the nutritional value of diets for healthy living. This study aims to assess the nutritional and chemical composition of tiger nut drink from two communities (Odukpani and Ikom) in Cross River State.

Methods: The tiger nut drink samples were obtained in triplicates from the study area. The beverages were analyzed for key nutrients, including moisture, ash, protein, fat, fibre, and carbohydrates, alongside essential minerals (K, Na, P, Ca, Mg, Mn, Cu, Fe, Zn) and chemical characteristics (pH, Total solids, Total titratable acidity, Total energy and % Sugar) using standard methods.

Results: The results showed marked ($P< 0.05$) variations in nutrients and chemical properties of tiger nut juice between the two communities in Cross River State. The most abundant of the nine mineral elements was potassium (K) with values ranging from 167.24±0.05 to 170.27±0.02, followed by phosphorus (P) with values ranging from 40.11± 0.04 to 44.13±0.06 and the least was iron (Fe) with values ranging from 0.12± 0.01 to 0.17± 0.04. The pH values ranged from 6.50±0.34 to 6.70±0.55. Other chemical characteristics were within the range safe and suitable for human consumption and promotion of human health. Moisture content was the highest, ranging from 75.77±0.33 to 76.62±0.42, followed by carbohydrate (16.34±0.32 to 18.40±0.67) and the least was ash (0.29±0.06 to 0.36±0.02).

Conclusion: The study indicated that the two samples of tiger nut juice contain reasonable quantities of nutrients which could be beneficial to human health. Although, there were marked variations in nutrient composition and chemical properties between the two locations, the results of this study provide new information about the nutritional value of tiger nut drinks from varied local production.

***Keywords*:** Chemical Characteristics, Cross River State, Nutrients, Tiger Nut Juice, Two Communities

1. INTRODUCTION

Tiger nut milk is a beverage usually produced as aqueous extract from fresh tuberous rhizome of tiger nut plant (*Cyperus esculentus*) [1]. It is a nutritious plant-based juice with natural sweet taste, and vary in chemical properties from the dairy milk [2], although, cow milk still has a better product image in terms of acceptability [3]. In developing countries, most vegetarian appreciate non-dairy milk than diary milk and dairy products due to the fact that non-diary milk has low contents of cholesterol and lactose as well as being inexpensive [4, 5, 6, 7]. Tiger nut milk is a light brownish liquid with a low viscosity and sweet-acidic taste, and has a short shelf life (less than 24 hours) which could be extended depending on the storage condition [8, 9]. However, most local producers usually enhance the flavour,

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nutritional and functional properties of the product by adding supplements such as date palm, coconut, cloves, ginger, etc during preparation of tiger nut milk product [10, 11]. The host plant, tiger nut (*Cyperus esculentus*) from where tiger nut juice is obtained is a monocotyledonous perennial species with fibrous, upright root system and characteristic height of about 24-55 cm [1]. Tiger nut is known by several names in Nigeria based on the various ethnic groups such as 'aya' (Hausa), 'aki-Hausa' (Igbo) and 'ofio' (Yoruba) [12, 13, 14]. Tiger nut is rich in valuable nutrients such as energy, fat, carbs, fibre, glucose, and protein [15], disaccharide; D-saccharose, which yields D-glucose, D-galactose, D-xylose and D-arabinose upon hydrolysis [16], as well as essential nutrients, including vitamins and minerals, and digestive enzymes like catalase, lipase, and amylase, are abundant [13]. Several phytochemicals and antinutrients, including alkaloids, cyanogenic glycosides, resins, tannins, sterols, oxalates, phytates, and saponins have been extracted from raw tiger nut. Tiger nut milk has been shown to be rich in protein and fibre, [17], as well as ample quantity of moisture, ash, crude fat and carbohydrate making it an attractive alternative to dairy milk and an excellent ingredient for the development of nutritious beverages [18]. Tiger nut has been reported to contain appreciable proportion of moisture, crude fibre, ash, carbohydrates, lipid and crude protein [19]. Tiger nut tubers contain rich contents of vitamin B1, C, and D, sodium, potassium, and iron [20]. The potential health benefits associated with the use of tiger nut drink include antioxidant and anti-inflammatory activities, prevention of diabetes, colon cancer, obesity, and coronary heart diseases [13, 21, 22], as well as for people whose body system cannot tolerate gluten or allergic to cow milk [1, 17]. Again, it is beneficial to people experiencing digestive disorders, flatulence and diarrhea due to its contents of digestive enzymes such as amylase, lipase, and catalase, proteolytic and lipolytic enzymes, as well as help in preventing arteriosclerosis as a result of high amount of oleic acid and arginine [23, 24, 25]. However, despite the potential benefits of consumption of tiger nut drink, the nutritional content of the product could be affected during the process of extracting tiger nut milk from tiger nut tubers [26, 27]. Again, there is limited information on the effect of extraction procedure and spices or other substances supplementation on the nutritional and chemical composition of tiger nut beverages. Therefore, this study aimed to assess the nutritional and chemical composition of tiger nut beverages marketed and consumed in two communities in Cross River State. The findings of this study could provide valuable information for the development of nutritious and functional beverages for local communities in the study area.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Biological Materials

The biological materials used for this research were tiger nut juice samples obtained in triplicates from the study area.

2.1.2 Equipment, Chemical and Reagents

The following equipment were used for this study; Digital pH meter, Burette and Pipettes, Beakers 100 and 250 ml, refractometer, Soxhlet extractor, Volumetric flask 50, 100, 250 and 500ml, Spectrophotometer, Kjeldahl flask, buchner funnel, UV/VIS, and Atomic Absorption Spectrophotometer (AAS). Mayor's reagent/Wagner's reagent, ferric ammonium sulphate, thioglycollic acid. All reagents were of analytical reagent grade. De-ionized water was used for all dilutions. Nitric acid was not less than 65%, with a density of approximately 1.4 g/mL Catalyst/salt mixture (Kjeldahl digestion tablets), Nitrogen-free, anhydrous Sodium Sulphate, Sodium hydroxide solution, 50 %, w/v, Boric acid solution and Standardized HCl solution.

2.2 Methods

2.2.1 Study Area

The study areas were Ikom and Odukpani, which are located in Cross River State, Nigeria, and share similar tropical humid climates with distinct ecological features. Cross River State lies between latitudes 5°32' and 4°27' North and longitudes 7°50' and 9°28' East, bounded in the North by Benue State, in the South-west by Akwa Ibom State, in the West by Ebonyi and Abia States. The State shares an internal frontier to the East with the United Republic of Cameroon, and its Atlantic coastline is to the south, where the Calabar River meets the sea. Ikom has Coordinates of 6°05′N 8°37′E / 6.083°N 8.617°E and has a tropical climate with a short dry season and a lengthy wet season. Odukpani is located at Latitude: 5° 58' 0.08" N Longitude: 8° 42' 22.75" E, and experiences a tropical humid climate with wet and dry seasons, characterized by high temperatures, rainfall, and humidity. Odukpani is rich in biodiversity, with vast expanses of tropical forests. Both areas face challenges related to deforestation, driven by factors like illegal logging and agricultural expansion, leading to reduced rainfall, soil erosion, and other ecological consequences. The

state generally has a tropical-humid climate with wet and dry seasons, with average temperatures ranging between 15°C and 30°C and annual rainfall between 1300 and 3000mm [28, 29].

2.2.2 Collection of Tiger nut juice samples.

Tiger nut juice used for this study was obtained from two (2) locations, Ikom and Odukpani Local Government Area of Cross River State, Nigeria. Samples were collected in rubber containers and taken to the laboratory for analysis. Samples were collected in triplicates using Complete randomized block design.

2.2.3 Wet Digestion of Extract

Ten millilitres (10mL) of the samples were measured and evaporated. Twenty milliliters (20mL) of nitric acid and 10mL of perfluoric acid were added to the mixture and kept in a fume hood overnight at ambient temperature to predigest the sample. The temperature was gradually increased to about 120°C as the process of digestion started with a completion time of about 70-80 minutes indicated by the appearance of white fumes. The mixture was left to cool and the content of the tubes were transferred to a 100 mL volumetric flask. The volume of the contents was diluted to 100mL with distilled water. The wet digested solution was transferred to plastic bottles and labeled for use in mineral determination [30].

2.2.4 Determination of Mineral Elements of Tiger nut juice

The concentrations of zinc, calcium, magnesium an iron in the tiger nut juice samples were determined using spectrometer after acid digestion. Spectrophotometric method was used in analyzing for Ca, K, Mg, Na, Mn, P, Fe and Cu contents of tiger nut juice as described by [31].

2.2.5 Determination of Chemical properties of Tiger nut juice

Ten milliliters of the juice was dispensed into a beaker and the pH was determined with a previously standardized pH meter. The pH meter was calibrated using phosphate buffer of pH 4.0 and 7.0 [32]. Standard method of [33, 34], was used to measure the titratable acidity. Five grams of concentrated fruit juice was homogenized in distilled water (20ml) and filtered through what man No. 1 filter paper. Phenolphthalein was added to 20ml of the filtrate as indicator and titrated against 0.05 M NaOH and the Titratable acidity was calculated. Total solids content was determined by evaporating a known weight of juice in anoven (Fisher Isotherm 175) at 105°C for 2-3 h. The solid left after evaporation was weighed and used to calculate the total solids. The total solids content is a measure of the amount of material remaining after all the water has been evaporated [32]. Total energy of the tiger nut juice was estimated using the modified Atwater factor (4 X protein + 4 X carbohydrate + 9 X fat) according the [35] method. The hand held sugar refractometer ATAGO (0-32oBrix) was used to determine the sugar content of the Tiger nut juice. The hand held prism of the refractometer was cleaned and a drop of the tiger nut juice was placed on the prism and closed. The total sugar content (obrix) was read off the scale of the refractometer hold firmly close to the eye according to the method of [31].

2.2.6 Determination of proximate composition of Tiger nut juice

The proximate composition, moisture, crude protein, ash, and crude fibre content of the tiger nut juice were determined using standard methods of [31].

2.3 Statistical Analysis

Values of mean data obtained from the replicate readings were used to calculate standard error and data were subjected to analysis of variance (ANOVA).The differences in the means were tested at 0.05 level of probability [36].

3.0 RESULTS

The mineral elements of tiger nut drink from Odukpani and Ikom are presented in Table 1. Higher contents ($P< 0.05$) of sodium (1.36±0.04 mg/100g), potassium (170.27± 0.02 mg/100g), phosphorus (44.13±0.06mg/100g), iron (0.17± 0.04mg/100g), manganese (0.08± 0.03mg/100g) and copper (0.30± 0.02mg/100g) were recorded in tiger nut juice from Ikom comparable to the contents of sodium (1.32±0.03mg/100g), potassium (167.24 ± 0.05mg/100g), phosphorus (40.11±0.04 mg/100g), iron (0.12± 0.01mg/100g), manganese (0.15± 0.02mg/100g) and copper (0.23±0.07mg/100g) from Odukpani (Table 1). Conversely, higher contents ($P< 0.05$) of calcium (1.65± 0.12mg/100g), magnesium (4.60± 0.20 mg/100g), and zinc (0.17± 0.02mg/100g) were recorded in tiger nut juice from

Odukpani comparable to the contents of calcium (1.63±0.21mg/100g), magnesium (4.57± 0.14mg/100g), and zinc (0.16± 0.02mg/1 00g) from Ikom (Table 1). The pH value of tiger nut juice from Ikom (6.70±0.55) was higher than that from Odukpani (6.50 ±0.34). In addition, the total titratable acidity (0.14± 0.04 %), total energy (482.70± 0.13 Kcal) and % sugar (11.83±0.15) contents of tiger nut juice at Ikom were higher than the total titratable acidity (0.13± 0.04 %), total energy (477.26± 0.92 Kcal) and % sugar (11.26± 0.24) contents of tiger nut juice at Odukpani, while the total solids (10.32 ± 0.45 %) of tiger nut juice at Ikom was lower than that of Ikom (9.61± 0.33%) (Table 2). The moisture (76.62 ±0.42%), crude fat (4.69± 0.72%) and crude fiber (1.30± 0.22%) contents of tiger nut juice from Odukpani were higher than the moisture (75.77±0.33%), crude fat (3.74± 0.13 %) and crude fiber (1.21±0.15%) contents of tiger nut of Ikom, while the crude protein (0.92± 0.20%), ash (0.36± 0.02%) and carbohydrate (18.40± 0.67%) contents of tiger nut juice at Ikom were higher than the crude protein (0.76 ± 0.50%), ash (0.29± 0.06%) and carbohydrate (16.34± 0.32%) contents at Odukpani (Table 3).

Table 1: Mineral elements composition of Tiger nut juice

Mineral elements (mg/100g)	Odukpani	Ikom
Sodium	1.32 ±0.03	1.36±0.04
Potassium	167.24±0.05	170.27±0.02
Calcium	1.65±0.12	1.63±0.21
Magnesium	4.60±0.20	4.57±0.14
Phosphorus	40.11±0.04	44.13±0.06
Zinc	0.17±0.02	0.16±0.02
Iron	0.12±0.01	0.17±0.04
Manganese	0.15±0.02	0.18±0.03
Copper	0.23±0.07	0.30±0.02

Mean ± standard error from three replicates

Table 2: Chemical characteristics of Tiger nut juice

Parameters	Odukpani	Ikom
pH	6.50±0.34	6.70±0.55
Total solids (%)	10.32±0.45	9.61±0.33
Total titratable acidity (%)	0.13±0.04	0.14±0.07
Total energy (Kcal)	477.26±0.92	482.70±0.13
% Sugar	11.26±0.24	11.83±0.15

Mean ± standard error from three replicates

Table 3: Proximate composition of Tiger nut juice

Parameters (%)	Odukpani	Ikom
Moisture	76.62±0.42	75.77±0.33
Crude protein	0.76±0.50	0.92±0.20
Crude fat	4.69±0.72	3.74±0.13
Ash	0.29±0.06	0.36±0.02
Crude fiber	1.30±0.22	1.21±0.15
Carbohydrate	16.34±0.32	18.40±0.67

Mean ± standard error from three replicate

5. DISCUSSION

The mineral elements of tiger nut drink from Odukpani and Ikom are presented in Table 1.There were significant ($P< 0.05$) variations in mineral nutrient contents of tiger nut juice between the two locations. Both macronutrients and micronutrients were examined in this study. Mineral analysis is one of the valuable parameters in assessing the nutritional potential of food products. It plays a critical role in metabolic, structural, and regulatory functions of the cells. The sodium contents of tiger nut were relatively low at the two locations, indicating the safety reliability of this products with cardiovascular health [37]. The contents of phosphorus in the tiger nut were relatively high at the two locations, and agrees with the results of [38] of slightly levels of phosphorus in tiger nut beverages hence, supporting

its functional role in bone health, energy production, and cellular repair. The calcium levels of tiger nut at the two locations relate well with that reported by [39] in range of 1.07±0.04-1mg 100 g using fresh tiger nut tubers. Calcium plays a critical role in bone density, muscle contractions, and enzyme function. The magnesium levels of tiger nut at the two locations relate well with that indicated by [17], who reported that magnesium content of tiger nut milk samples is within the range 1.14 -1.32 mg/L. This supports the crucial role of this mineral in maintain the growth of bones and regulating cardiac cycle as well as proper functioning of muscles and nerves [40]. The levels of copper, iron, manganese and zinc in this study support the important roles of micronutrients in diets. Manganese and zinc are important micronutrients for antioxidant defence, bone development, immune function and wound healing [38]. Iron plays a vital role in movement of oxygen to red blood cells and enzymes such as flavoprotein [39]. Copper is essential in the production of red blood cells, formation of bones and hematopoiesis [39]. The pH (6.70±0.55) and total titratable acidity (0.14± 0.04 %) values of tiger nut juice from Ikom were higher than that the pH (6.50 ±0.34) and total titratable acidity (0.13± 0.04 %) values from Odukpani (Table 2). The pH and total titratable acidity are important measures for evaluating microbial activity, substrate metabolism, and overall product quality in the juice. pH changes in milk and other fermented products have been observed in related studies and could be attributed to metabolic activities of lactic acid bacteria (LAB) and other fermentative microbes [41]. However, a lower pH value and a higher total titratable acidity are critical indicators for microbiological safety of the juice, which can inhibit the growth of spoilage and pathogenic organisms [40]. In addition, the, total energy (482.70± 0.13 Kcal) and % sugar (11.83±0.15) contents of tiger nut juice at Ikom were higher than the total energy (477.26± 0.92 Kcal) and % sugar (11.26± 0.24) contents of tiger nut at Odukpani, while the total solids (10.32 ± 0.45 %) of tiger nut juice at Ikom was lower than that of Ikom (9.61± 0.33%) (Table 2). These results indicate that gross energy contents of the tiger nut milk in the two locations were higher than the 76.4 - 114.58 kcal reported by [40], as well as the low energy value of tiger nut milk reported by [42]. The higher energy values of tiger nut juice reported in this study could be attributed to the varieties of tiger nut tubers used as a raw material. The total energy of 482.70± 0.13 Kcal and 477.26± 0.92 Kcal recorded in this study compared favourably with the gross energy content of pasteurized and unpasteurized tiger nut milk prepared using fresh tiger nut tubers is 373.22 and 488.68 KJ/g, respectively as reported by [42]. There were marked ($P<0.05$) variations in proximate composition of tiger nut juice between the two locations. The moisture (76.62 ±0.42%), crude fat (4.69± 0.72%) and crude fiber (1.30± 0.22%) contents of tiger nut juice at Odukpani were higher than the moisture (75.77±0.33%), crude fat (3.74± 0.13 %) and crude fiber (1.21±0.15%) contents of tiger nut juice at Ikom, while the crude protein (0.92± 0.20%), ash (0.36± 0.02%) and carbohydrate (18.40± 0.67%) contents of tiger nut juice at Ikom were higher than the crude protein (0.76 ± 0.50%), ash (0.29± 0.06%) and carbohydrate (16.34± 0.32%) contents at Odukpani (Table 3). This study showed varied proximate contents of tiger nut juice between the two locations, but indicated rich composition of moisture, crude fat, carbohydrate and crude fiber, which corroborate the report that tiger nut milk are rich carbohydrates, dietary fibre, and essential fatty acids [37]. The enhanced nutrient composition of the tiger nut juice could be attributed to the additional ingredients or substances used to improve the quality of the products. This is in line with reports that adding supplements are usually added to tiger nut milk in order to enhance the flavour, nutritional and functional properties of the product [10, 11].

6.0 CONCLUSION

The local brands of tiger nut milk from Odukpani and Ikom evaluated in this study were rich in mineral elements and proximate contents. The chemical properties of tiger nut indicated safety profiles good for human consumption. The results of this study provide new information about the nutritional value of tiger nut drinks from varied local production. The research showed that the tiger nut drink used often in the study area is a nutritious and energizing beverage, hence, proof effective for enhancing human health.

DECLARATIONS

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

- Samuel E. Osim: Conceptualization, Methodology, Supervision, Writing – Review & Editing
- Oghenetega Emeriewen: Data Collection, Laboratory Analysis, Writing – Original Draft
- Favour C. Ogele: Data Analysis, Visualization, Writing – Review & Editing

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